

KOPLIK (Henry) al

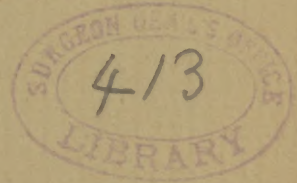
THE
ETIOLOGY OF EMPYEMA
IN CHILDREN.

BY

HENRY KOPLIK, M.D.,

ATTENDING PHYSICIAN FOR DISEASES OF WOMEN AND CHILDREN TO THE EASTERN DISPENSARY,
NEW YORK.

READ BEFORE THE AMERICAN PEDIATRIC SOCIETY,
JUNE, 1890.



[Reprinted from the Transactions of the American Pediatric Society, June,
1890, published in "Archives of Pediatrics," October, 1890.]



THE

ETIOLOGY OF EMPYEMA

IN CHILDREN.

I AM certain that you will all agree with me when I say that the subject of the etiology of empyema in childhood is one of the first importance. This theme and its kindred factors are at the present time subjects of the most sincere and painstaking investigation all over the world. The present communication is only a preliminary one to the more complete paper to be published at some future day. In it the special aim is to inquire into the etiology of empyema in infancy and childhood from the stand-point of modern bacteriology. In infancy and childhood the factors of predisposition and exciting cause are modified in their action by the nature of the material dealt with, a growing, developing organism. This is seen particularly well in the chest, where severe processes are borne with a resistance and impunity not to be expected in the adult. We know that in practice these conditions will vary the prognosis. In the disease empyema, it is the etiology which explains in part why the treatment of the disease is more satisfactory in childhood than in the adult. In studying the disease we must revert constantly to the adult subject, and I confess that when these studies were first begun such reference to the adult was obligatory, for none of the works extant treat of the disease in childhood in a satisfactory manner. I found in the course of my work certain similarities between the bacteriological results as published in the adult and in childhood tending to uphold in important points the

identity in the pathology of the affection as common to the child subject and the adult. A brief *résumé* of the investigations in the field is as follows: The most complete series of observations upon empyemas was published by A. Fraenkel (*Ueber die bakterioskopische Untersuchung eiteriger Ergüsse Charité Annalen*, 1888, p. 14). He had published fragmentary communications upon the same subject at a much earlier day, anticipating Weichselbaum, who, as early as 1886, appeared with a paper (*Wiener Jahrbücher*) confirming the most important views put forth by Fraenkel. Previous to this, the notices in the literature of bacterioscopic work were imperfect, but they gradually led up to the more complete investigations to be detailed. Flesch and Vaillard (*Archives de Physiol. normale et pathol.*, 1886, p. 162), as also Landouzy, doubt the possibility of a genuine sero-fibrinous pleurisy as the result of exposure to cold. According to these authors all pleurisies whose etiology is not evident are the result of an expression of a localized tuberculosis. The exposure to cold only plays a predisposing rôle in the etiology. In sero-fibrinous pleurisies the diagnosis is more difficult because our methods of investigation yield a negative result in most cases. We are thus allowed a mere surmise upon their true character. Ehrlich (*Beiträge zur Ätiol., etc., Pleurit Ergüsse Charité Annalen*, 1882, p. 207) investigated with stainings the bacterial character of fluids obtained from the chest in forty-five cases of pleurisy. Of these, nine cases were tubercular, twenty simple pleurisy, six carcinomatous, and nine empyemas of various kinds. A negative result by cover-glass stain does not exclude tuberculosis. In nine cases the sputa of which showed tubercle bacilli, the bacilli were found in the pleuritic exudate in only two cases. Ehrlich thinks that the bacilli became entrapped in the fibrin masses of the pleuritic exudate, and thus escaped detection in the cover-glass. A. Fraenkel does not reject the possibility of a sero-fibrinous pleurisy as the result of an exposure to cold. In these cases the vital forces are so reduced by cold as to enable micro-organisms situated in the subpleural tissues to become potent. Cold may in this way be an important predisposing factor in the causation of pleurisy. In this class of cases, where micro-organisms have not been isolated, a certain

percentage have proven, upon autopsy, to be tubercular. The etiology of the remainder is still a matter of speculation. In some sero-fibrinous pleurisies there has been a positive result, immense quantities of streptococci having been found in one case (Fraenkel). In others, where micro-organisms have been present, the exudate became purulent subsequently. Fraenkel makes three principal groups of his cases of empyema. This grouping is based upon the bacteriological results. The first group yielded streptococcus pyogenes upon investigation of the pleuritic exudate. These organisms may have been derived from the lung, a previous pneumonia (Weichselbaum), or there may not have been any preceding pneumonia. Such empyemas may (?) result from a traumatism without perforation of the chest, the trauma acting, as stated above, as a predisposing cause. The second group includes all those empyemas which result from pneumonia, post-pneumonic or concomitant with pneumonia. In all of these cases the diplococcus pneumoniae (Fraenkel) is found in pure forms in the pleuritic exudate. This micro-organism is not only capable of producing suppuration, but in these cases suppuration is maintained by the closed pleural cavity, the presence of blood-vessels, and a different nutritive medium than in the artificial culture, where these micro-organisms soon lose their virulence; Fraenkel's cases followed or complicated fibrinous pneumonia. The third group is that including the tubercular empyemas. A fourth group of cases includes those empyemas which complicate some extra pleural focus of suppuration, pyæmic cases. The above cases in which the pneumococcus was found followed lobar pneumonia. Inasmuch as in children the processes in the lung, when pneumonia is present, are of a broncho-pneumonic character in most cases below a certain age, it will be necessary here to anticipate by citing the researches of Weichselbaum, who found that the pneumococcus of Fraenkel was also an important etiological factor in broncho-pneumonia, lobular pneumonia (*Ueber die Ätiol der acuten Lungen und Rippenfel Entzündung*). The division of pneumonia into lobar and lobular has an anatomical but not an etiological basis. Both varieties of pneumonia may be caused by the same micro-organism. Weichselbaum also examined cases of pleuritis, and found not

only the diplococcus pneumoniae, but also the streptococcus pneumoniae or pyogenes and the staphylococcus pyogenes aureus. I will, in addition, only refer to the recent discourses of Von Ziemssen (*Klin. Vorträge*) and Liebermeister (*Deutsche Medicinische Wochenschrift*, Nos. 10, 11, 12, 13, 1890), as excellent *résumés* of our present knowledge in the pathology and therapy of the pleurisies and empyemas. My own material is made up of cases obtained from my dispensary and private practice, and I have also studied the disease in the wards of the Mount Sinai Hospital, New York. I wish to sincerely thank Dr. Barnim Scharlan, who has charge of the children's wards at this hospital, for the very liberal manner in which he has placed his cases at my disposal; without access to such clinical material the work which I present would be less satisfactory and simply fragmentary. The experimental work which forms the basis of my studies was done in the Carnegie Laboratory of New York. I am indebted to Dr. E. K. Dunham, of this institution, for many professional courtesies. The micro-photographs were prepared from my own preparations, and are the work of Dr. R. H. Cunningham, house physician to the Mount Sinai Hospital. The apparatus used was the most improved Zeiss, and the beauty of the work speaks for itself. I am indebted to the doctor for his patience and enthusiasm.

Methods of investigation.—In making the following studies I have adhered closely to the methods now so well known by all the investigators of the Koch school. The chest of the child was first carefully cleansed, a carefully sterilized needle and syringe was then introduced, and a small quantity of pus withdrawn, placed in a sterilized tube, and taken to the laboratory for immediate investigation. A new syringe was used in each case for reasons which will appear evident to all. These hypodermic syringes, after they have been once the receptacle of pus, must be difficult to thoroughly clean, and to do away with this objection I never used a syringe twice, but discarded the old syringes. The new syringe, after having been carefully prepared by washing with sublimate, alcohol, ether, and sterile-distilled water, was attached to needles sterilized by dry heat in the usual way. The pus was immediately sown upon plates and tubes, and crude cover-glasses were also prepared and stain-

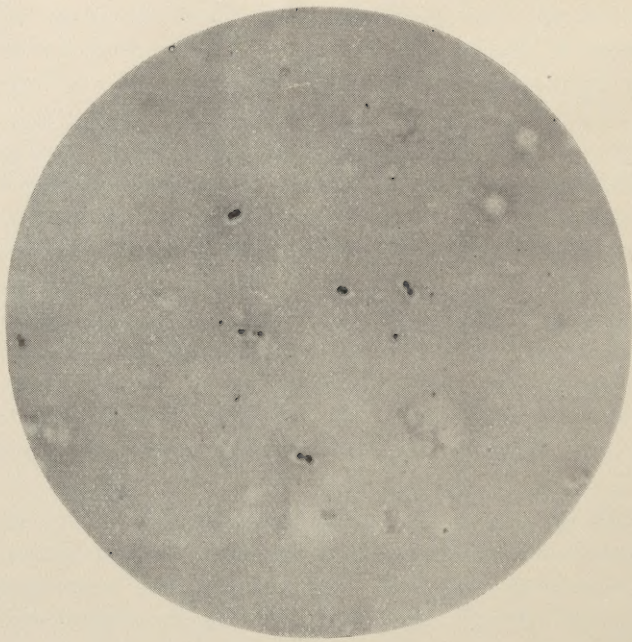
ings made. When pure cultures were obtained from the agar or bouillon in the case of the diplococcus pneumonia, or from agar, gelatin, and bouillon in case of streptococci or staphylococci, they were used for experimental work. Or the pus was, according to Weichselbaum's method, inoculated into agar tubes, and when sufficient growth was attained new tubes and plates were made, the latter to test the purity of cultures. The above was carefully carried out in each case. The media used were blood serum, agar-agar, gelatin, glycerin-agar bouillon, and potato. I found that the most uniform results were obtained with the agar invented by Weichselbaum; it has the requisite consistency and moisture. The pure cultures were suspended in sterile-distilled water and injected into animals, or the pure bouillon culture was injected. Rabbits, guinea-pigs, and rats were the animals used. The cover-glasses which had been prepared with crude pus were stained with methyl violet or with gentian violet by the Gram method. They were stained also for tubercle bacilli. I have determined to report to you my results in twelve cases of empyema, and I will divide them, as Fraenkel, into groups.

GROUP I.—This group includes those cases in which the bacterioscopic results are not uniform, and in which the micro-organisms found are not diagnostic. The streptococcus pyogenes or the staphylococcus pyogenes aureus were found. I have three such cases to report. Thus far they occurred in children aged seven years (female), eleven months (male), and twelve years (male), respectively. In all of these cases the history, prior to and during illness, failed to elicit any clinical possibility of tuberculosis. In all, the bacterioscopic results were as above. I leave the clinical histories of all the cases of this paper for future publication. In two cases the streptococcus or chaincoccus was found which in every way as to growth and action corresponds to the streptococcus pyogenes. In the third case, a child, aged eleven months, the staphylococcus was found which in every way corresponds to the staphylococcus pyogenes aureus. The above group finds its exact counterpart in the group of similar cases investigated by Fraenkel in the adult. Eliminating the presence of tuberculosis, we are still in doubt as to the exact etiology of these cases; we might with

Fraenkel suppose that they could have complicated a pneumonia, for Weichselbaum proved that in pneumonia there were present (as mixed infections) both the streptococcus pyogenes and the staphylococcus pyogenes aureus. Again, these empyemas could arise spontaneously, as explained above, with the predisposing aid of exposure and cold or a slight traumatism, the above micro-organisms being present in the subpleural tissues. In none of my cases was a traumatism mentioned in the history. On the whole, it seems uncertain as to how these empyemas originate. The organisms found, as you see, are not characteristic.

GROUP II.—This group includes those cases in which I have been able to establish the presence of the pneumococcus of Fraenkel and Weichselbaum in the purulent exudate. This organism was found in pure form and uncontaminated in all the cases of this group. I was perhaps fortunate in working with a simple purulent exudate and obtaining my specimen pure and uncontaminated. In all the cases the crude pus spread upon cover-glasses and stained showed the capsule-coccus singly or in pairs or chains, and the lancet-shapes could be beautifully seen. These diplococci could be well stained by the Gram method. The pure cultures with Weichselbaum agar were characteristic, and I leave their description for a more lengthy paper. There are seven cases to report in this group, six males and one female child, aged five years, twelve months, two and a half years, three and a half years, two years, and two and a quarter years, respectively. I wish to direct particular notice to two cases of this group. In both of these cases the effusion, when drawn from the chest with the hypodermic syringe, was at first clear and serous, in one case being devoid even of fibrin flocculi. In both cases, however, the diplococcus pneumonia was isolated in pure culture, and its virulence established upon animals. This micro-organism could also be stained by spreading a drop of the crude exudate upon cover-glasses. If a drop of this exudate were placed under the microscope, the diplococcus could be seen, as also a few lymphoid cells. These cases subsequently became pronounced empyemas, the serous having turned into a purulent exudate. This tends to support the assertion of Fraenkel that when an

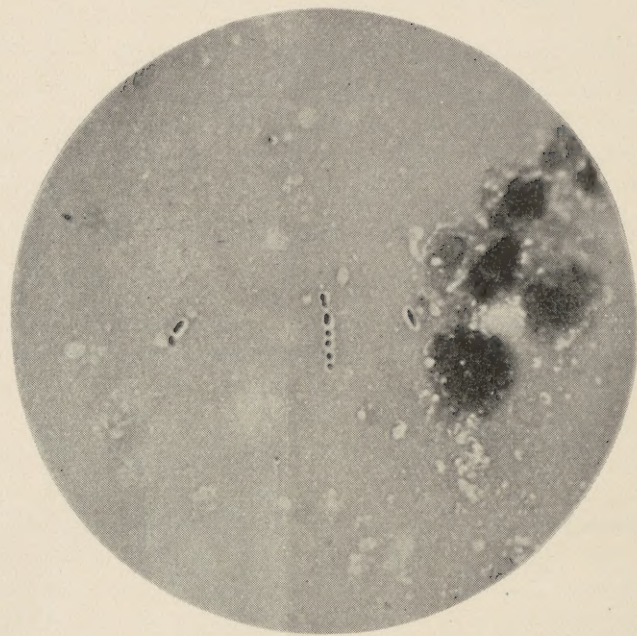
PLATE I.



(MICRO-PHOTOGRAPH.)

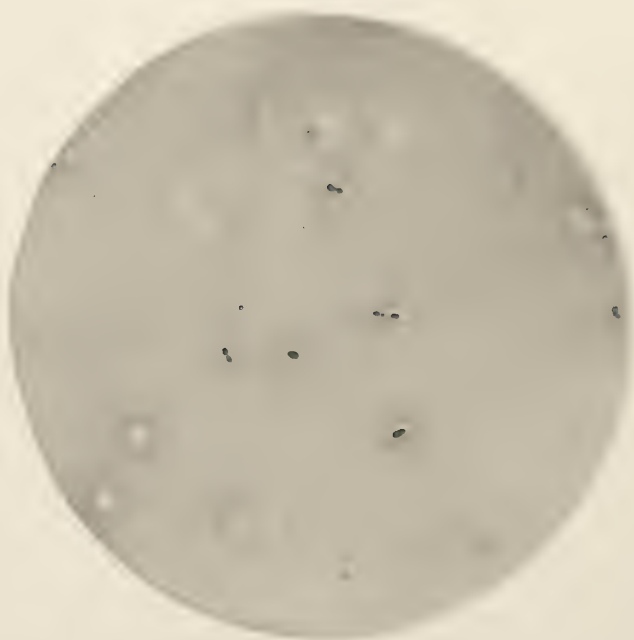
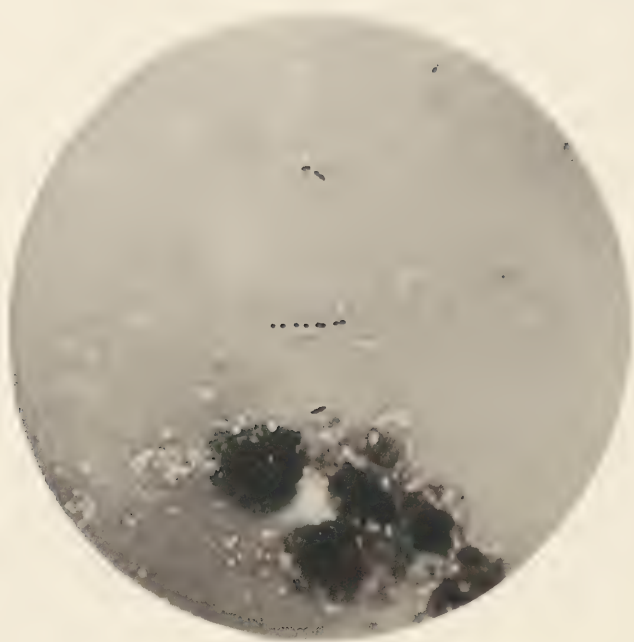
1. *Diplococcus pneumoniae* in the crude pus of Group II, spread upon a cover-glass and stained with gentian violet; shows the capsule; Zeiss apochromatic lens, projection ocular No. 2; $\times 1000$; zircon light.

PLATE II.



(MICRO-PHOTOGRAPH.)

2. *Diplococcus pneumoniae* in the crude pus of empyemas of Group II; Shows capsule, diplococci single and in chains, also the "candle-flame shape." Cover-glass specimen; gentian violet; Zeiss apochromatic lens, projection ocular No. 2; $\times 1000$; zircon light.



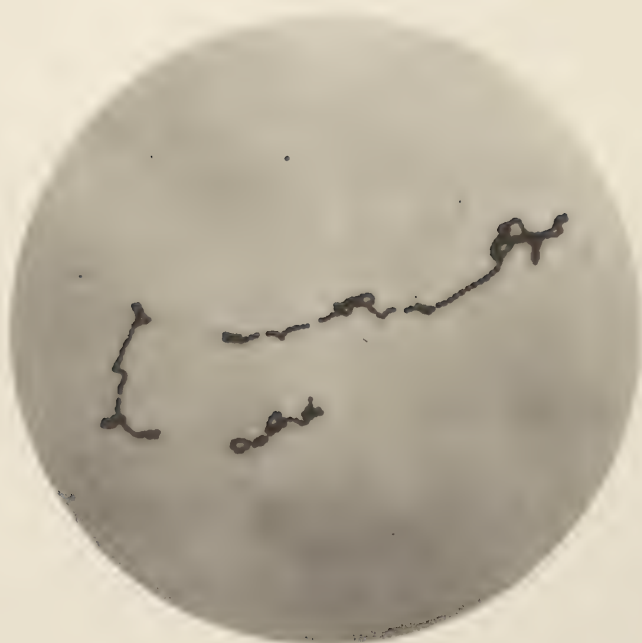
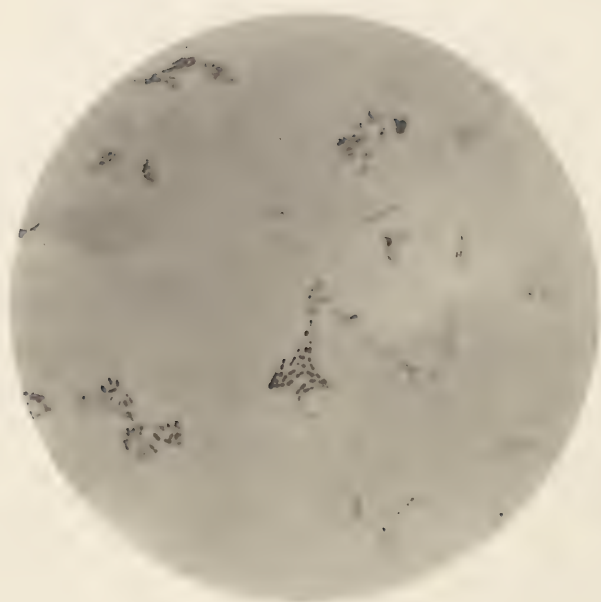
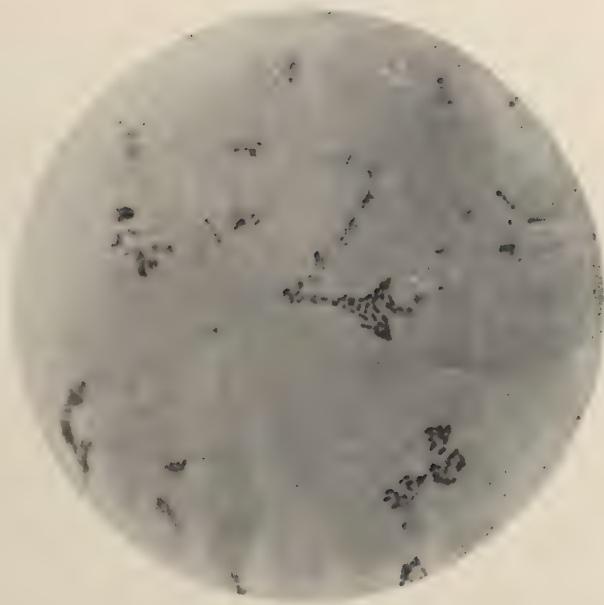


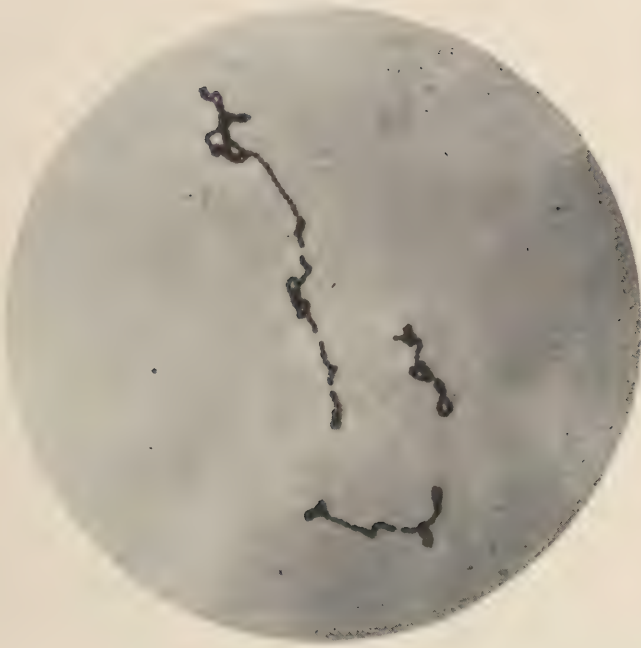
PLATE III.



(MICRO-PHOTOGRAPH.)

3. Pure culture of *diplococcus pneumoniae* obtained from the pus of a case of empyema in Group II. Agar culture; Gram stain; Zeiss apochromatic lens, projection ocular No. 4; $\times 1000$; zircon light.

PLATE IV.



(MICRO-PHOTOGRAPH.)

4. Pure culture of *streptococcus pyogenes* obtained from the pus of a case of empyema in Group I. Bodilian culture; cover-glass specimen; gentian violet stain; Zeiss lens as previous specimen; $\times 1000$; zircon light.

exudate, serous in character, contains streptococci, it can be predicted that it will shortly become markedly purulent. The same could be stated of the diplococcus pneumoniae, for we know of its established capabilities to produce suppuration. The above also shows that the character of a serous exudate cannot be established until examined bacteriologically. In this way we can make a differential diagnosis between those exudates which, like the above, are acute in character and those which are serous, and contain no micro-organisms and fail to give any results with our media, and the majority of which, in the *adult* at least, are tubercular. The presence of a serous fluid in the hypodermic may be of little use in proving the purulent character of the fluid in the chest as far as gross appearance is concerned. It is well known that the pus of empyema, even in the chest, has a tendency to separate into two portions; that portion in the dependent part of the chest may contain most of the lymphoid cells and be markedly purulent to the macroscopic examination, while the upper stratum which we have aspirated may be serous. The clinical diagnosis of pleurisy with serous effusion is only temporary at best, and we must be always on the lookout for pus, especially if the serous fluid aspirated contains streptococci or diplococci. It has been customary formerly to assume that if a fluid has been serous at the first aspiration and subsequently became purulent, it had been contaminated from without by the hypodermic. If such effusions had been carefully examined, I am sure micro-organisms would have been established at the very outset. When a serous exudate has from the very first been proven free from organisms and then subsequently turns purulent, then we may think of some contamination or mixed infection. When the bacterioscopic result is as positive as in the cases of this group, I think it is not necessary to prove the clinical presence of a pneumonia in order to trace the origin of the empyema. The isolated presence of such a virulent micro-organism as the diplococcus is sufficient proof as to the origin of such inflammatory processes of the pleura. As stated above, the cultures of all the cases in this group were inoculated upon animals with results identical with those of Fraenkel and Weichselbaum. I shall publish them in the near future.

GROUP III.—Empyemas occurring in tubercular subjects, as far as investigations in the adult teach us, may be encapsuled and localized to narrow limits by adhesions in the chest, or they may be diffused over the whole pleural surface. They may complicate a tubercular condition of the lungs, or they may be present when there is no pulmonary tuberculosis. The general result is not changed by these conditions, the prognosis is always bad and conditional: a partial recovery is the result in the most favorable cases. The tubercular cases in the adult are the most unsatisfactory to treat. Though we relieve certain symptoms, other conditions are superimposed by our treatment which are not less harassing to the patient than were the symptoms of the original condition. In adults the bacteriological investigations may (Fraenkel) yield an absolutely negative result. Our inoculations of the pus from the pleural cavity upon various media yields us nothing, and thus far experiments upon animals have been equally unsuccessful. This may be because our present methods and media fail to reach these cases; or, better still, because, though the tubercle bacilli may exist in the pleural adhesions and the tubercle tissue of the adhesions and thickened pleura, they may be present in such small numbers in the exudate, at least in that withdrawn from the chest, as to fail to grow when artificially cultivated. When a case, upon careful examination of the pus, gives an absolutely negative result, we are justified in assuming the possibility of a tuberculosis. In most of these cases where post-mortem has been made tuberculosis has been established. The second class of cases of a tubercular nature are those in which the sputa of the patient and the pus of the empyema show tubercle bacilli, both by stain and culture. Lastly, streptococci have in some cases been found to contaminate the pus in some of these tubercular cases (Fraenkel). In this last set of cases a contamination is assumed from the subpleural tissues or the lung. In children, as far as I know, no parallel investigations to the above are on record. I have only one case to report, a boy of eight years, in whom the empyema is tubercular. In this case tubercle bacilli were found in the pus of the chest, but it was contaminated by the presence of streptococcus pyogenes.

This corresponds to an adult case of Fraenkel's. This patient is still alive, and, though walking about, carries a large suppurating cavity in the chest, which refuses to close in spite of the enormous contraction of the chest wall and extensive resection of numerous ribs. There are no signs of tuberculosis discoverable in the healthy lung. It was not possible to obtain the sputa for examination. Thus far my experiments upon animals with the pus have been negative, the results being clouded by the presence of streptococci. It is not at all impossible for a tubercular empyema to make, if localized, an apparent temporary recovery; but whether such recoveries become permanent it is at present impossible to say. It is also problematic in these cases as to what is the real focus of trouble; why should a tubercular area in the lung, for a long time dormant, suddenly cause an empyema? We could here also invoke the predisposing exposure or traumatism. Tubercular empyemas are the most difficult to diagnosticate in some instances during the life of the patient. In children it is not always possible to establish a tuberculosis of the lung by physical exploration; the sputa is also difficult to obtain. These little patients have been so harrowed by the disease and its results, and the presence of paraphernalia of the ward is so associated in their minds with suffering, that when a bottle or spit-cup is placed before them they resist all attempts to obtain a specimen of sputa.

GROUP IV.—The last group of empyemas in children belongs to that class of cases in which we can, with a degree of probability, point to a focus of suppuration situated outside the chest as the possible source of infection. These cases include pyæmic infections, and correspond to that variety of empyemas which, in the adult, are found complicating puerperal cases, or cases with retropharyngeal abscess or peritonitis (Fraenkel). The case which I desire to place in this group occurred in a child aged four months, breast-fed, which, for two weeks previous to the chest-trouble, had been suffering from a deep burrowing abscess on one foot. Just before the appearance of this abscess the infant had been vaccinated, and at the time of consultation for the chest-trouble the vaccine pustule looked quite angry. The pus, withdrawn with the

usual precautions from the chest in this case, contained streptococcus pyogenes, which, upon inoculation, proved virulent in action. An animal inoculated with this pure culture died with multiple abscess of the liver and lung, general jaundice, and a large soft spleen. This case proved fatal in two days after pus was established in the chest, in spite of operation, dying with all symptoms of pyæmic infection. No autopsy was permitted.

The conclusion to be derived from the above is a forcible one, tending to show what a large proportion of empyemas in children follow or complicate processes in the lung of an acute character. With early and efficient treatment we can look all these cases hopefully in the face. Even those whose etiology is uncertain do not hold out such a bad prognosis to the patient. The tubercular and pyæmic cases are the stumbling stones of pediatric practice.

DISCUSSION.

DR. BOOKER, of Baltimore.—During the last six or eight weeks we have had an unusually large number of cases of empyema among the children at the Johns Hopkins Dispensary, having had five cases within that time, and Dr. Shaw has been making some investigations from a bacteriological stand-point.

The president then called on Dr. Shaw, of Baltimore, who said,—

I may state some of the results of the investigation, as they bear a close relation to the admirable paper just read. It is my regret to say that no examination was made of the pus of the first case. In the remaining four the pneumococcus was found on each occasion. The pus from two of these was inoculated in each case into a rabbit and a mouse, with the results that the pneumococcus was obtained in a pure culture. The mouse of the first case died on the fourth day, and the autopsy showed all of the organs to be infected with the micro-organism as also the blood, but the results on the rabbit were frustrated, owing to the fact that the needle of the syringe perforated the intestine from which a peritonitis was set up, in the fluid of which the colon bacterium was found. I may also say that the pneumococcus was likewise obtained, but no value was attached to the experiment.

In the second series of inoculation the rabbit died on the

third day, with marked evidence of infection in all of the viscera as before, and the pneumococcus was again obtained in pure culture. The mouse lived for some time after, so no value was attached to the autopsy.

In the pus of all examined the micro-organism was in a form we have never seen it before, being in chains of from four to seven in number, and surrounded by a continuous capsule. Some of these had peculiar hooked ends. I might say that it was not obtained in this form from the animals inoculated.

Volume begins with January Number.

ARCHIVES OF PEDIATRICS

**A MONTHLY JOURNAL DEVOTED TO THE
DISEASES OF INFANCY AND CHILDHOOD.**

EDITED BY

WM. PERRY WATSON, A.M., M.D.,

Attending Physician to St. Francis's Hospital and to the Central Dispensary (Department of Pediatrics);
Consulting Physician to St. Michael's Orphan Asylum, etc., Jersey City, N. J.

**THE ONLY MEDICAL JOURNAL IN THE ENGLISH LANGUAGE DEVOTED
EXCLUSIVELY TO THE DISEASES OF INFANTS AND
YOUNG CHILDREN.**

Containing nearly 1000 large octavo pages per annum.

SUBSCRIPTION PRICE, \$3.00 PER YEAR.

THE organization of the Section on Diseases of Children of the American Medical Association in 1880, of the Section on Pediatrics of the New York Academy of Medicine in 1886, and of the American Pediatric Society in 1888, all now in a flourishing condition, not to mention the great demand for Keating's "Cyclopædia of the Diseases of Children," or the wonderful success of the ARCHIVES OF PEDIATRICS, simply mean that the relation of pediatrics to general medicine is appreciated.

That the ARCHIVES shall keep abreast with the advancement in medical science, and retain its scientific and practical excellence, it will hereafter contain in addition to the original articles and current literature from the best German and French authorities, carefully revised clinical memoranda on the subject of pediatrics from the lectures of professors of the leading medical colleges of the country, together with original communications from our London, Paris, and Madrid correspondents.

The arrangement of the subject matter will be as follows:

I. ORIGINAL ARTICLES.

The mature opinions of the ablest writers on Pediatrics in this country and Europe.

II. CLINICAL MEMORANDA.

The bedside instruction and clinical lectures from Harvard, University of Pennsylvania, Jefferson Medical College, Bellevue Hospital Medical College, University of the City of New York, College of Physicians and Surgeons, New York, and New York Polyclinic and Post Graduate Medical School and Hospital, and others. These lectures will be carefully revised by the professors themselves.

III. CURRENT LITERATURE.

A practical résumé of the current pediatric literature of the world, arranged under the usual headings: 1, Hygiene and Therapeutics; 2, Medicine; and 3, Surgery.

SUBSCRIPTIONS MAY BEGIN AT ANY TIME.

J. B. LIPPINCOTT COMPANY, Publishers,

715 and 717 Market Street, Philadelphia.